

**Magdalena Urbańska<sup>1a</sup>, Tomasz Sojka<sup>2b</sup>, Przemysław Charzyński<sup>1c</sup>, Marcin Świtoniak<sup>1d</sup>**

<sup>1</sup> Nicolaus Copernicus University in Toruń, Faculty of Earth Sciences and Spatial Management, Department of Soil Science and Landscape Management, Toruń, Poland

<sup>2</sup> Regional Committee for Geography Olympiad, Poland

ORCID: <sup>a</sup><https://orcid.org/0000-0003-2175-4189>, <sup>b</sup><https://orcid.org/0000-0001-5526-3551>, <sup>c</sup><https://orcid.org/0000-0003-1467-9870>, <sup>d</sup><https://orcid.org/0000-0002-9907-7088>

<sup>c</sup> corresponding author: Charzyński Przemysław, email: [pecha@umk.pl](mailto:pecha@umk.pl)

---

## Digital media in soil education

---

**Abstract:** Teaching soil science as a part of geography subject is crucial, because students learn not only about soil properties, but also about conscious and rational use of the soil resources. Nowadays digital media play increasingly important role in education and can be employed both in geography classes and soil science. The article aims at comparing various multimedia tools used as a support in teaching on soil science and evaluation of trends concerning the use of these methods in education. The use of ICT during lessons should be purposeful, therefore a need arises to develop strategies on effective use of multimedia and methodological guidance in specific teaching situations. Social media and virtual reality games have changed the way young people perceive the real world, and this includes education. Thus, it is of value to attempt employing role-playing and elements of gamification in teaching soil science and geography lessons.

**Keywords:** soil science, geography, education, multimedia tools

### 1. Introduction

The soil cover is one of the most important environmental elements. Soil has many functions, from satisfying the elementary nutritional needs of a human to landscape protection. The knowledge of soil genesis, processes, its spatial diversity provides an opportunity to better understand the relation between biotic and abiotic components of the environment. Teaching basics of soil science as a part of geography subject is essential, because students learn not only about the properties of soil, but also about conscious and rational use of the earth resources. The digital media play increasingly

crucial role in education, and there are many opportunities to use this form of support when teaching on soil. Getting to know the digital media tools allows us to enhance the use of the information and communication technologies (ICT) in teaching. Possibilities offered by interactive devices, multimedia software, e-books and internet resources can aid the development of teaching methods.

The aim of the article is to compare various multimedia tools used to support teaching of soil science and to evaluate trends in the use of these methods in education.

### 2. Principles, aims and objectives of multimedia methods in geography and soil education

Using multimedia in schools depends on both external and internal factors. The former involve the legislation, education curricula and teacher's promotion paths, whereas the latter

comprise willingness to increase the attractiveness and effectiveness of lessons. The multimedia effect is understood as an increase in the effectiveness of the learning and teaching

process achieved by means of incorporating multisensory stimuli. It is related to the intersensory transfer, which leads to transferring sensory sensitivity from one group of receptors to another (Żuk, 1996).

Psychologists who conduct studies on multimedia in education point to numerous advantages of their use in teaching. Information transfer via many channels enables their parallel processing. Thus, students can save the time otherwise required for reprocessing the information (Żuk, 1996). Information coming to the student through multiple sensory channels can be immediately verified and compared. In addition, the message stimulating the visual cortex of the *brain* leads to the activation of attention. Multimedia-based learning takes advantage of the brain's capability to make connections between visual and verbal representations of content, and improves understanding. This supports the transfer of acquired knowledge to other situations.

Interactive multimedia are a natural environment for the entertainment of "digital natives"—contemporary students—thus using them wisely in the form of edutainment could be an efficient motivation for learning. The use of ICT in education is also changing the role of the teacher from the "sage" to the "guide" in the world of knowledge (Kida and Neczaj-Świdorska, 2007). With smartphones and the constant internet connection, students today have unlimited access to the information they need.

To enable adequate teaching-learning process within the scope of geography using multimedia, certain conditions must be met (Pliszka, 2005). The teacher and students must be aware of the purpose of digital media-assisted education, which is often omitted in various teaching materials. Unfortunately, excessively much attention is focused on the teaching materials, and not enough on preparing people to use them. The issue of teachers' qualifications should be considered in two interdependent areas. The teacher should have knowledge and skills to use computer, and also be familiar with at least basic applications and educational software. It is particularly important to know how to use the computer in educational work (Pliszka, 2005). The implementation of didactic goals is accomplished by various methods selected by the teacher. Properly selected and used digital media

can contribute to more effective education. Some of them, in particular the interactive ones, will help activate students and engage them in the didactic process. The multiplicity of information allows the teachers to individualize the learning process and achieve better education results.

The aims of geography teaching presented by Zajac (1997) are a detailed and subject-focused version of the general taxonomy by Niemierko (1975). The analysis performed by the authors made it possible to assign functions that multimedia software can perform in the teaching-learning process pertaining to geography of soils. The use of digital media in geography classes helps better accomplish the aims of teaching on the subject in all taxonomic categories. Presenting information in a multi-coded form improves students' remembrance. Interactive animations, videos and maps present difficult spatial and time processes in a way that is simplified and easier to understand.

Due to their diversity, attractiveness and interactivity, multimedia tend to engage the student more closely in the learning process. They allow for the implementation of basic activities, such as: exploring the world, experiencing, evaluating and, sometimes, performing simulations that involve changing and transforming the reality. As in the case of chemistry teaching (Strykowski, 1996 after Gulińska, 1997), multimedia in geographical education can include cognitive, emotional and motivational functions (Cornish, 2012). There are essentially two approaches to comparing the aims of geographical education and the concepts of computer-aided learning. The first one refers to the computer as a device designed to transmit information, facilitating its passive reception and assimilation. The second approach treats it as an educational tool for supporting mental processes and improving skills through various types of activities and exercises.

In the commentary to the core curriculum for the third education stage, as well as in the core curriculum of general education in geography from 2017 (Dz.U. 2012, item 977; Dz.U 2017 item 356), the attention is drawn to the use of ICT as an important source of geographical information. Their use facilitates collecting, processing and presenting information.

Methodological recommendations include suggestions to use modern media in teach-

ing regional geography –aerial photographs, 3D images, multimedia presentations, internet resources etc. It should support the analysis of landscapes also in the context of the relationship between natural environment and human activity.

At the time of changes in schools related to the reform of Polish education, there is a need to establish a core curriculum for (terminated but still existing) secondary schools with core curriculum for eight-year primary schools.

Current legal documents written in the form of a core curriculum directly determine geographical education. It is the basis for creation of geography textbooks. The possibility of using multimedia with reference to general geography classes is aimed at the third stage of education and primary school classes as part of the current core curriculum of general education for both secondary and primary schools (Table 1).

**Table 1.** Possibilities of supporting the implementation of geography teaching aims for the third educational stage (as well as 8-Year primary school classes) with the use of multimedia (Authors' own study based on the core curriculum of general education: Dz.U. 2012, item 977; Dz.U. 2017, item 356)

Educational purpose	General requirements	Achievement of a specific aim using the multimedia
I. Using different sources of geographical information.	The student observes and makes field measurements; can use plans, maps, photographs, drawings, charts, statistical data, source texts, as well as information and communication technologies to collect, process and present geographical information.	Visualization of information in a different form that is attractive to the student by means of using various combinations of transmission codes; The ability to present and create digital tables, charts, maps, diagrams and drawings; Development of the ability to acquire, use and evaluate information from various sources.
II. Identifying relationships and dependencies; explaining phenomena and processes.	The student uses the basic geographical vocabulary to describe and explain phenomena and processes taking place in the natural environment, economy and social life in various spatial scales (local, regional, national, global); student understands the nature-human relationship; explains the spatial diversity of the natural environment conditions and human activities on Earth.	Processing of the reality by simulating natural and socio-economic phenomena occurring at different time and greater scales; Improving the understanding of relationships between the natural environment and human activity, and presenting them with the use of interactive tools.
III. Using knowledge and geographical skills in practice.	The student uses knowledge and geographical skills to better understand the contemporary world, and applies the acquired skills in life, among others, to rationally use the environmental resources.	Activation of perceptual processes, observation, comparison, deduction and reduction reasoning using interactive materials; Developing the ability to use information technologies as a key-competence in self-education and lifelong learning.
IV. Development of social skills and competences.	The student develops: Curiosity by getting interested in his or her own region, Poland, Europe and the world; Awareness and a sense of responsibility for the natural and cultural environment of the region and Poland; Patriotism and a sense of identity (local, regional, national), while retaining respect for other nations and communities – their systems of values and ways of life.	Shaping emotional attitude towards the surrounding reality manifested on a global scale, as well as towards local natural and socio-economic phenomena and processes; The use of various tools to stimulate the curiosity of the world and to familiarize students with its diversity, developing respect for other religions, ways of life and culture.

### 3. Soil education as part of geography teaching

Issues pertaining to soil education, outside geography classes, are also touched upon on other school subjects, such as biology and chemistry. However, the detailed requirements for the third and fourth educational stage as well as for primary school classes (according to the new core curriculum) indicate only six of them as directly related to soil education. The core curriculum for the grammar school contains similar soil issues to those included in the

new core curriculum for primary school and for secondary school (high school). As a general rule, the implementation of these topics involves issues related to the biosphere and usually is scheduled near the end of a school year. It is important to ensure that the didactic tools and methods employed are as effective as possible. The use of multimedia in soil education can contribute to an increase in the educational effectiveness of the discussed issues (Table 2).

**Table 2.** Teaching on soil science and possible application of ICT evaluation (Authors' own study based on the core curriculum of general education: Dz.U. 2012, item 977; Dz.U.2017, poz. 356)

Teaching content	Specific requirements	Use of multimedia
<i>Junior high and primary school (according to the core curriculum of 2017)</i>		
Selected issues of physical geography/ climate, soil and vegetation zones in Africa.	Using thematic maps the student presents the relationship between Earth's axial tilt and climatic zones, and shows the climate impact on the diversity of vegetation and soils on Earth; Using thematic maps the student explains the climate, soil and vegetation zonation in Africa.	Access to digital maps, satellite images from different parts of the world; Use of GIS software to display individual thematic layers, and to facilitate the analysis of the diversity of vegetation and soils on Earth.
Location and natural environment of Poland/ The main soil types of Poland.	The student: Lists the main types of natural resources in Poland and his own region: forests, waters, soils, mineral resources; Using the map, describes distribution of resources and determines their economic importance; Distinguishes the most important features of Brown soils, Podzolic soils, Chernozems, Ordinary alluvial soils and rendzinas <sup>1</sup> , indicates their location on the map of Poland and assesses their agricultural suitability.	Access to digital maps at various scales allows the student to describe the distribution of soils in Poland and his or her region.
<i>Secondary school (high school) – basic level</i>		
Human-environment relation and sustainable development.	The student presents examples of excessively intensive agricultural use of soils and incompetent agronomical techniques causing soil degradation in different parts of the world, which in consequence leads to decline in food production and, in some regions of the world, to starvation and poverty.	Analysis of various digital materials (maps, charts, statistical data) obtained from the Internet also on different time scales; Enables quick access to a large number of materials from various sources (e.g., organizations, offices).
<i>Secondary school (high school) – extended level</i>		
Earth's spheres – biosphere and pedosphere.	The student describes soil-forming processes and discusses the characteristics of the main types of zonal and azonal soils, as well as assesses their agricultural suitability.	Animations and interactive digital schemes that facilitate the understanding of soil-forming processes. Extended access to photos and drawings of soil profiles, access to free-of-charge soil databases.

Earth's spheres –bio-sphere and pedosphere.	The student digs a soil pit and observes the soil profile near the place of his or her residence.	Facilitating collection and preparation of data with regard to the place of observation. Use of an application on mobile devices (smartphones, tablets) to immediately collect information, document, process and publish it on the web.
Geography of Poland –natural environment.	The student explains the occurrence of zonal and azonal soils in Poland.	Analysis of various digital materials (maps, charts, statistical data) and GIS tools to explain the occurrence of zonal and azonal soils.

<sup>1</sup> Official translations of Polish names (Kabała et al. 2019)

At the level of lower secondary and current primary schools, students – using maps – learn about the relationship between the climate and vegetation and soil zones.

Multimedia offer a possibility to quickly access up-to-date digital maps that allow the students to describe the distribution of soil resources and determine their economic importance. In secondary schools, at the basic level, information on soils is discussed in the context of agriculture geography. First of all, attention is paid to the causes and effects of soil degradation due to improper management. Multimedia educational tools expand the resources available to the teacher who presents the issues, as he or she can explain the changes through the analysis of digital data and maps on different time scales. At the extended level, students broaden their knowledge about soil-forming processes, which are very frequently hard to understand for them (authors' own data, unpublished). Animations, digital diagrams and drawings – supplemented with teacher's comments and notes as necessary – can contribute to a better understanding of soil processes. Digital multimedia can help students plan their field activities and observe the soil profile. Mobile devices and dedicated applications that can be used directly during a field trip can improve the effectiveness of fieldworks.

Juxtaposition of the detailed requirements with the possibilities offered by the implementation of multimedia in education shows that their use significantly expands the resources available to the teacher. One should also note that multimedia materials, unlike the traditional ones, can be easily updated, which constitutes a crucial advantage. An example is a map of soil types prepared for

the Internet atlas of the Kuyavia-Pomerania Province (Bednarek et al., 2015; <http://atlas.kujawsko-pomorskie.pl/>). Digital maps, spatial data, aerial and satellite photos allow us to analyze matters related to soil in various spatial scales. The available software enables easy collection and comparison of data.

An important element of soil education are field trips. Mobile devices, such as smartphones or tablets with installed applications allow the students to collect data directly in the field. Thanks to the built-in cameras, the data can be documented, saved, shared and instantly exchanged with other users via the Internet. Such an approach to field trips not only broadens the range of possibilities as far as collecting and recording information is concerned, but also, above all, introduces edutainment elements into the activity. Edutainment combines valuable educational content with elements of entertainment, and it is considered one of the most effective strategies for transferring knowledge and shaping social attitudes among the digital natives (Brooks, 2010). This is largely due to the less formal nature of the teaching-learning process and an attractive formula for (but not limited to) young recipients. Students at times forget that they are in fact learning thanks to game elements (Aksakal, 2015), which is perhaps the most notable advantage of this approach. The educational content is usually provided in a formula that is attractive to the recipient, which means that the student is not always aware that, while being entertained, he or she acquires knowledge or develops new skills. Multimedia used in this way can support the implementation of tasks in a group, stimulate cooperation and develop social skills.

## 4. Digital textbooks in soil education

On the Polish educational market there is a number of different digital textbooks that contain issues related to soil education. Most of them are prepared by publishers who specialize in traditional textbooks. They are often exact copies of analogue textbooks with only minor additional options, such as enlargement of selected graphic elements, inclusion of hyperlinks to movie clips, animations or slide shows displayed as side notes.

In order to determine the position of multimedia textbooks on physical geography that are on the market, we examined the features and structure of the available materials and performed a critical assessment of their educational value. Digital textbooks intended for geography classes are predominantly traditional textbooks supplemented with some multimedia features (Czerski and Wawer, 2014). There are still no fully interactive and intelligent textbooks on the Polish market that would answer students' questions, engage their interest, and improve their understanding.

Multimedia textbooks can also come with numerous multimedia supplements, including, among others, multimedia atlases, interactive boards, e-maps and interactive tourist maps, multibooks, multitecs, portals with educational content intended to be used by teachers, diagnostic portals and e-exercises. All the aforementioned elements can be successfully employed in geography education, thus also soil geography. Those that are applicable in class improve the teaching of the subject and make the teaching-learning process more attractive, thus bolstering students' interest in soil-related information.

Some of the first multimedia textbooks that appeared on the Polish education market were EduROMs. They contain all the required material for teaching school subjects at the level of primary, secondary and high schools (<http://www.2.ydp.com.pl>). EduROMs are ready-to-use presentations with boards demonstrating lessons contents enriched with numerous video clips, voice recordings, animated presentations and maps that facilitate understanding of a particular issues, including the field of soil education. EduROM can be used in various forms both individually (on computers in a computer lab) or collectively (on an interactive board).

The creators of the program supplemented it with numerous interactive exercises and quizzes, which can be used on an interactive whiteboard during the lesson.

There are special elements integrated in the program that can be used to work with EduROM, which can be helpful during geography learning:

- Photo browser – about 2,000 photos (each picture can be enlarged);
- Solar System – a multimedia presentation enabling observation of planetary motion from different perspectives, reflecting spatial relationships between planets and their orbits, and providing basic information about the planets in the Solar System;
- Tables – dozens of essential geographical tables, contents of which can be sorted alphabetically and by keywords, and which present all the important numerical data;
- Dictionary – contains several hundred geographical terms explained in a way that is easy to understand;
- Maps – the collection contains several hundred maps falling into a multimedia atlas that comes with an index, legend and an options to zoom in on maps;
- Biographies – a set of 40 unconventional richly-illustrated biographies of famous geographers and travelers, including facts related to their lives that are usually omitted in encyclopedic descriptions.

Other options of the above mentioned software package aimed at achieving even better results include:

- Remember – a list of most important information;
- Notes – an electronic notebook that allows students to make own notes;
- Search – a tool for finding information by category and keywords;
- Bookmarks – a tool that allows for storing the most important or the most interesting pages of the e-book in the computer memory.

A major disadvantage of this product is that some multimedia resources are not adapted to the age of students. The level of knowledge presented on slides is definitely too high for an average student. There are also termino-

logical errors. For example, instead of providing a proper definition of “genetic horizons”, it is simplified to “soil layers”. The e-textbooks from Nowa Era are an electronic version of the paper-back editions with built-in multimedia materials. Teacher and students can work with them in many environments, including the web browsers on iOS devices. E-books are available on the publisher’s website (<http://www2.ydp.com.pl>). It can also be installed along with an e-book application for Android devices. this solution provides access to textbooks even if the device is disconnected from the Internet.

Using e-books is possible after activating a code obtained from the publisher. The structure of the textbooks is clear and the interface user-friendly. A considerable disadvantage of this particular digital textbook is that it comprises small quantity of multimedia materials. In the case of the analyzed soil science topics there were only two pictures and a zoomable map, which could hardly be called a multimedia feature. The lessons do not contain any movie clips or animations.

Another example of a multimedia tool is a series of e-textbooks entitled *Świat pod lupą* (<https://epodreczniki.pl/b/swiat-pod-lupa/PwgzmmYwR>). It is available online and every Internet user has free access to it. It was developed as a part of a government project co-financed from the European Social Fund. It is a component of the government program for developing students’ and teachers’ competences involving the use of information and communication technologies – *Digital School*. The program was implemented by the Center for Education Development. The e-textbook of geography was created as one of the 64 dedicated to various general subjects on all levels of teaching.

The technological partner was the Supercomputing and Networking Center from Poznan (<http://www.man.poznan.pl>). Developed as a result of team work, these e-textbooks constitute a comprehensive collection of modern educational resources dedicated to teachers and students. Each user has access to them via a range of devices (computer, laptop, tablet, smartphone, e-book reader). They can be used either online or offline, and are compatible with various operating systems (Android, IOS, Windows). They are suitable for users

with dysfunctions, e.g. the visually impaired, who can print out contents in the Braille alphabet. The resulting e-textbooks can be integrated with other environments: e-journals, e-learning platforms, blogs, websites. Thus, they can be used in a creative way, and maybe a valuable support in any forms and methods related to work with students (<http://www.epodreczniki.pl>). It is also possible to generate a textbook in the form of PDF files in two versions – for the student or the teacher. QR codes (QR - Quick Response two-dimensional barcode developed to quickly read and write URL data) provide quicker access to their contents.

Issues in the field of soil education can be found under the following topics:

1. “The impact of climate on biodiversity and soils” (junior high school) (<https://epodreczniki.pl/a/jak-klimat-wplywa-na-bioroznorodnosc-i-zroznicowanie-gleb/DV4EXUBAh>) (Fig. 3). The multimedia supplement in this textbook is very limited. In addition to the photo gallery, illustrations, diagrams, tables and map, there are no movie clips or animations.
2. “The diversity of soils and vegetation on the territory of Poland” (junior high school) (<https://epodreczniki.pl/a/zroznicowanie-gleb-i-roslinnosci-na-obszarze-polski/DSM0RxNIH>) –two hyperlinks to definitions (on soil and soil-forming process)and five quizzes, two of which lack photographs.

On High School level the only topic related to soils is “Degradation of soils in the world and its consequences”(https://epodreczniki.pl/a/degradacja-gleb-na-swiecie-i-jej-skutki/DuguSPvVG). There are two movie clips: *Let’s talk about soil* and *Soil degradation and its prevention in the Philippines* and 3 quizzes.

Soils are also discussed in topic “Problems resulting from the exploitation of renewable and non-renewable resources of the Earth”. The major advantage of this e-textbooks is free access both online and offline. A rich methodical supplement (<https://epodreczniki.pl/search?query=geografia&format=e-materialy>) paired with a substantial number of interactive exercises further increase the attractiveness of this particular e-textbook.

Teachers using textbooks of Nowa Era have access to a tool called *multiteka* (*Multiteka – Oblicza geografii 1* [Nowa Era <https://www>.

dlanauczyciela.pl/zasoby/szkoly-ponadgimnazjalne/geografia/oblicza-geografii-zr/czesc-1/?f:11[0]=469]). It is a form of database containing multimedia materials, which can be used in two modes. The first is the *resource* mode, where the user searches for the desired content arranged thematically. Multiteka includes: animations, movies, didactic games, graphics, maps, slide shows and tables. Appropriate materials can be found using the search filter and then added to *my lessons* mode. From there they can be displayed using a multimedia projector. The analysis of the resources included in the multiteka proved that they are not always adapted to the educational level.

A big practical problem of the media published by Nowa Era (e-textbooks and materials in the multiteka) is the lack of possibilities to integrate them. Switching between the two programs takes time and makes it difficult to work

during the lesson. The resources contained in both are often duplicated. It seems that the ideal solution, at least from a practical point of view, would be to combine both programs. The ability to freely choose ready resources, to put them in the place chosen by the teacher on the margin of the digital version of the textbook would allow for more efficient use of the collected materials. A good solution on the part of geographical education is also to provide a geographical multimedia textbook with simple GIS functions. Displaying individual layers of digital maps and making simple measurements would facilitate a lot of comparisons and analyzes. The option of zooming in and out the map content and displaying the legend by clicking an appropriate icon does not make it an interactive map, but only provides a few simple digital elements.

## 5. The use of educational portals

With development of the Internet and social media in particular, popularization of geographical science and soil knowledge has become easier, and an increasing number of institutions engaged in this kind of activities. This typically involves posting various educational resources on websites and in social media, as well as organizing various actions to promote knowledge. Educational portals could be also an important tool for distance learning (Świtoniak et al., 2018).

While pedology knowledge is frequently promoted abroad (e.g. in Scotland: <http://www.hutton.ac.uk/learning/dirt-doctor>), in Poland similar endeavors have only started in recent years. The efforts include the website of the Soil Education Committee of the Polish Society of Soil Science (<https://sites.google.com/site/edukacjaoglebawawstwa/>) as well as Facebook site of the Center for Soil Education – Soil Museum (<https://www.facebook.com/Centrum.Edukacji.Gleboznawczej.Muzeum.Gleb/>), which contains didactic ideas and links to documentary films. An example of a campaign aimed at popularizing and educating in soil knowledge is “The Soil of the Year” initiated in 2018 by the Polish Society of Soil Science. Rendzina was selected the soil of 2018 and Chernozem of 2019 (Fig. 1).

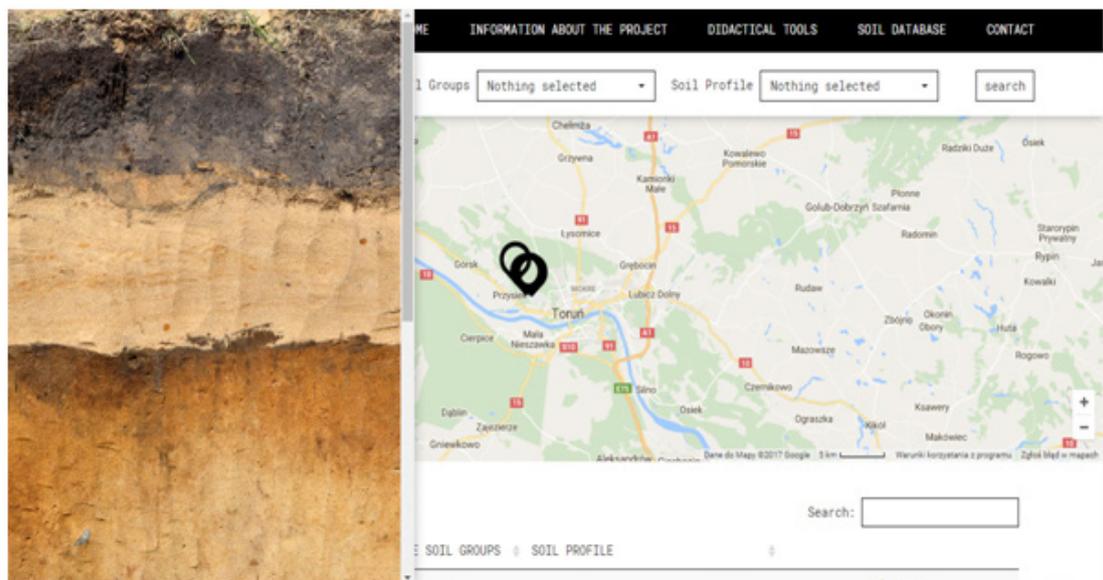


Figure 1. Logos of “The Soil of the Year 2018 and 2019”

However, not all educational web portals have guidelines for teachers in the form of methodical materials. Interesting multimedia materials that can be potentially used during a

geography lesson are also developed as part of international projects carried out at universities. One example that can be used in soil education is the portal created in relation to the FACES Erasmus+ project (<http://www.sites.google.com/site/centraleuropesoils>). Its effect is, among others, soil database (<http://www.soils.umk.pl/database>) that can be used in geography lessons

at the extended level of high school. It could also be a valuable material for students in schools where geography is taught bilingually. The portal structure offers an option to search for any type of soil from the available list, or by clicking on a symbol on the map. A photo of soil pits appears in the window that opens along with physical and chemical data presented in tables (Fig. 2).



**Figure 2.** Example of a soil profile along with its location retrieved from the soil base developed as part of the FACES project (Source: <http://www.soils.umk.pl/database>, access: May 2019)



**Figure 3.** Example of a spherical panorama taken from the soil base – developed as part of the FACES project (Gleyic Umbrisol from Brodnica Lake District) (Source: <http://www.soils.umk.pl/database>, access: May 2019)

Spherical panoramas are a considerably valuable element of the portal. These are photographs depicting the landscape (surroundings), within which the soil profile was made. They give the opportunity to view the area in a 360 degree perspective. This provides a direct

reference of the soil profile to the natural environment, in which it is located, and enables the analysis of a given soil in the context of soil-forming factors: terrain, water conditions and vegetation (Fig. 3). The database is still expanding. Portal creators increase the

number of places, countries and regions where soil profiles were made and various soil types were documented. Using the educational resources available on this portal it is possible to successfully implement the provisions included in the core curriculum with reference to the analysis of spatial distribution of

soils and the impact of vegetation, climate or anthropopressure on their development and degradation. Educational websites constitute an extensive source of knowledge and facts, and the amount of information stored in various forms is overwhelming (Świtoniak et al., 2018).

## 6. Conclusions

The issues presented above by no means exhaust topics related to multimedia supporting soil education. Creation of educational multimedia is undoubtedly a great chance to modernize teaching and learning process, and make it more attractive for students of the “digital natives” generation. Perhaps, in time’s perspective, they should incorporate a number of technologies from the field of artificial intelligence. Such materials should include a formal representation of knowledge contained in the textbook, reasoning methods for answering questions and natural language processing that would be capable of understanding user’s questions paired with natural language generation system to produce answers (Chaudhri et al., 2013).

Modern and attractive didactic tools are created within the framework of various educational projects. The use of ICT during classes should be purposeful, therefore a need arises to develop strategies on effective use of multimedia and methodological guidance in specific teaching situations. National and regional Centers dedicated to support training and professional development of active teachers should diagnose their needs in this regard and provide appropriate courses.

The multimedia materials are typically created by the publishers of textbooks. They are usually an integral part of said material, or are meant to complement it. The analysis shows that they are not always useful in the teaching and learning process. Sometimes they are not adapted to the age of students or cannot be used to accomplish the objectives indicated in the core curriculum. Prac-

tioners and geography educators who deal with the theory of geographical education (including soil education) should be ready to express their opinions on published multimedia teaching materials. Therefore, the society should be stimulated and encouraged to review the multimedia tools on offer in terms of the educational value to provide feedback to their creators.

The changes taking place in the education system and the elimination of junior high schools provide an opportunity to review the existing educational solutions. Thus, elements that have a positive impact on the efficiency of education should be retained, while the least effective ones should be eliminated.

It should be stressed that even modern, web-based digital teaching and learning materials may be not exciting enough to captivate the digital natives. Majority of them require interaction, competition and opportunities to impress one another in virtual reality. Social media and virtual reality games have changed the way young people perceive the real world, and that also includes the education process, which has to be supported by role-playing and elements of gamification. Gamification is the process of introducing game-related principles in education – especially those related to user experience and engagement. Since gamers voluntarily spend long hours playing games, it seems only natural to make use of this strong motivation to enhance the experience in the classroom and during field activities related to geography and soil science.

## References

- Aksakal N., 2015. Theoretical View to The Approach of The Edutainment. *Procedia - Social and Behavioral Sciences* 186, 1232-1239.
- Bednarek R., Świtoniak M., Mendyk Ł., 2015. Soil Types and Subtypes map circa 1:700 000. [In:] Kozieł Z. (Ed.) *Atlas of the Kuyavian-Pomeranian Voivodeship*. Nicolaus Copernicus University, Toruń, 54-55.
- Brooks C., 2010. The Young Net Project - GeoInformation and Edutainment. [In:] Donert K. (Ed.), *Using GeoInformation in European Geography education*, Vol. IX. International Geographic Union - Home of Geography, Roma, 64-68.
- Chaudhri V., Cheng B., Overholtzer A., Roschelle J., Spaulding A., Clark P.R., Greaves M., Gunning D., 2013. *Inquire Biology: A Textbook that Answers Questions*. *AI Magazine* 34(3), 55-72.
- Cornish P., 2012. *Multimedia Made Easy: Geography lessons using multimedia technology*. Scottish Association of Geography Teachers.
- Czerski W., Wawer R., 2014. Digital school – opportunity or threat to the education? *Dydaktyka Informatyki* 9, 104-113 [In Polish with English abstract].
- Dz.U. 2012, poz. 977. Rozporządzenie Ministra Edukacji Narodowej z dnia 27 sierpnia 2012 r. w sprawie podstawy programowej wychowania przedszkolnego oraz kształcenia ogólnego w poszczególnych typach szkół (<http://www.isap.sejm.gov.pl>, access: December 2017) [In Polish].
- Dz.U 2017 poz.356. Rozporządzenie Ministra Edukacji Narodowej z dnia 14 lutego 2017 r. w sprawie podstawy programowej wychowania przedszkolnego oraz podstawy programowej kształcenia ogólnego dla szkoły podstawowej, w tym dla uczniów z niepełnosprawnością intelektualną w stopniu umiarkowanym lub znacznym, kształcenia ogólnego dla branżowej szkoły I stopnia, kształcenia ogólnego dla szkoły specjalnej przysposabiającej do pracy oraz kształcenia ogólnego dla szkoły policealnej (<http://men.gov.pl/wp-content/uploads/2016/11/geografia-podstawa.pdf>, access: April 2019) [In Polish].
- Gulińska H., 1997. *Strategia multimedialnego kształcenia chemicznego*. Wydawnictwa Naukowe UAM, Poznań [In Polish].
- Kabała C., Charzyński P., Chodorowski J., Drewnik M., Glina B., Greinert A., Hulisz P., Jankowski M., Jończak J., Łabaz B., Łachacz A., Marzec M., Mendyk Ł., Musiał P., Musielok Ł., Smreczak B., Sowiński P., Świtoniak M., Uzarowicz Ł., Waroszewski J., 2019. Polish Soil Classification, 6th edition – principles, classification scheme and correlations. *Soil Science Annual* 70(2), 71-97.
- Kida M., Neczaj-Świdarska R., 2007. Interactive met hod of teaching adults. *E-mentor* 4(21), 57-61 [In Polish with English abstract].
- Niemierko B., 1975. *Testy osiągnięć szkolnych - Podstawowe pojęcia i techniki obliczeniowe*. Wydawnictwa Szkolne i Pedagogiczne, Warszawa [in Polish].
- Pliszka M., 2005. Warunki stosowania komputerów w nauczaniu i uczeniu się geografii w aspekcie celów kształcenia geograficznego. [In:] Kopeć K. (Ed.), *Współczesne formy i metody w dydaktyce geografii*. Katedra Geografii i Rozwoju Regionalnego, Uniwersytet Gdański, Gdynia – Pelplin, 37-43 [In Polish].
- Strykowski W., 1996. Rola mediów w edukacji, *Edukacja Medialna* 2, 4-10
- Świtoniak M., Augustyniak D., Charzyński P., 2018. The Internet as a source of knowledge about soil cover of Poland. *Bulletin of Geography* 14, 91-98.
- Zajac S., 1997. Cele nauczania geografii. [In:] Piskorz S. (Ed.), *Zarys dydaktyki geografii*. Wydawnictwo Naukowe PWN, Warszawa [In Polish].
- Żuk T., 1996. The psychological basis of multimedial education. *Neodi dagmata* 22, 33-42 [In Polish with English abstract].

## Internet sources

- e-podręcznik „Świat pod lupą 1” <https://epodreczniki.pl/b/swiat-pod-lupa/PwgzmmYwR>, (access: April 2019).
- Multiteka – Oblicza geografii 1 (Nowa Era) [https://www.dlanauczyciela.pl/zasoby/szkoly-ponadgimnazjalne/geografia/oblicza-geografii-zr/czesc-1/?f:11\[0\]=469](https://www.dlanauczyciela.pl/zasoby/szkoly-ponadgimnazjalne/geografia/oblicza-geografii-zr/czesc-1/?f:11[0]=469) (access: April 2019).
- <http://atlas.kujawsko-pomorskie.pl/> (access: May 2019).
- [www.soils.umk.pl/database](http://www.soils.umk.pl/database) (access: May 2019).

[www.sites.google.com/site/centraleuropesoils](http://www.sites.google.com/site/centraleuropesoils) (access April 2019).

<https://sites.google.com/site/edukacjagleboznawstwa> (access June 2019).

[www.man.poznan.pl](http://www.man.poznan.pl) (access: April 2019).

[www.epodreczniki.pl](http://www.epodreczniki.pl) (access: April 2019).

<http://www2.ydp.com.pl> (access: April 2019).

[www.facebook.com/Centrum.Edukacji.Gleboznawczej.Muzeum.Gleb/](https://www.facebook.com/Centrum.Edukacji.Gleboznawczej.Muzeum.Gleb/) (access: May 2019).

<http://www.hutton.ac.uk/learning/dirt-doctor> (access: May 2019).